Center Independent Research & Development: GSFC IRAD

Precision High Altitude Star Tracker (PHAST)

Completed Technology Project (2013 - 2014)

Project Introduction

Motivation: The long, successful history of scientific ballooning, coupled with tightening budgets, has led to a surge of interest in the scientific potential of high-altitude balloon flights. Powerful new payloads are being enabled by advancing technologies (e.g. in detectors, high-speed computers, composite materials, etc.), and these experiments will open new discovery spaces for science at a small fraction of the cost of a space mission. Access to much of this discovery space will depend upon the ability to both measure and control instrument pointing to high precision. The Experiment: The Precision High Altitude Star Tracker (PHAST) is an unpressurized, high-precision, high-bandwidth star tracker for night and day operations aboard scientific balloocraft. It will enable pointing knowledge using commercial, off-the-shelf (COTS) hardware, and open-source code development. PHAST will take advantage of advances in detectors and ruggedized computers to design without a pressure vessel. The low-cost design (<$70k) will be demonstrated and validated on a shared-ride balloon flight. Subsequently, all drawings, design documents and software will be made available to the scientific community, upon request, at no cost, broadening access to this burgeoning field. Significance: The high performance afforded by this tracker will permit the development of pointing control architectures of reduced complexity and cost due to the elimination of redundant motion transducers such as multiple fiber-optic rate sensing gyros. PHAST will be designed without a pressure vessel, thus significantly reducing launch mass. Relevance to NASA: The PHAST development and testing program will advance our understanding of the limits of pointing knowledge for balloocraft. A timely and successful PHAST program will reduce cost and scientific risk for future balloon-borne missions and will be a fundamentally enabling component for experiments pushing the envelope of ballooning capabilities. 1.2 Objectives and Expected Significance By developing a new low-cost star tracker, with high angular precision, fast readout, and the capability of operating in both day and night conditions, we will be providing a new tool that promises cost savings for a wide range of future balloon missions. The capabilities provided by PHAST will be enabling for a number of potential science investigations.

Anticipated Benefits

This project could be successfully used by the Balloon Experimental Twin Telescope for Infrared Interferometry.

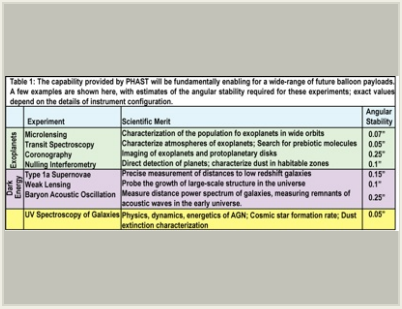

Table 1: The capability provided by PHAST will be fundamentally enabling for a wide-range of future balloon payloads. A few examples are shown here, with estimates of the angular stability required for these experiments; exact values depend on the details of instrument configuration.

	Experiment	Scientific Merit	Angular Stability
Exoplanets	Microlensing	Characterization of the population fo exoplanets in wide orbits	0.07"
	Transit Spectroscopy	Characterize atmospheres of exoplanets; Search for prebiotic molecules	0.05"
	Coronography	Imaging of exoplanets and protoplanetary disks	0.25"
	Nulling Interferometry	Direct detection of planets; characterize dust in habitable zones	0.1"
Dark Energy	Type 1a Supernovae	Precise measurement of distances to low redshift galaxies	0.15"
	Weak Lensing	Probe the growth of large-scale structure in the universe	0.1"
	Baryon Acoustic Oscillation	Measure distance power spectrum of galaxies, measuring remnants of acoustic waves in the early universe.	0.25"
	UV Spectroscopy of Galaxies	Physics, dynamics, energetics of AGN; Cosmic star formation rate; Dust extinction characterization	0.05"

Science areas facilitated by this technology

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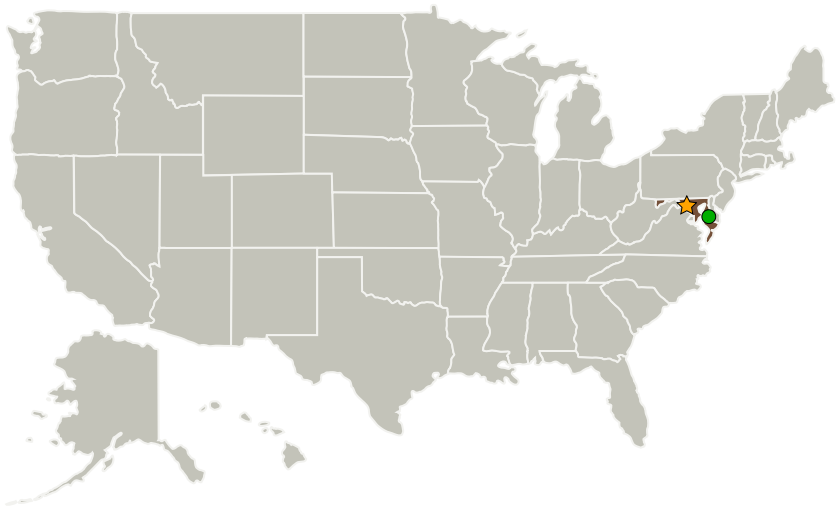
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
★Goddard Space Flight Center(GSFC)	Lead Organization	NASA Center	Greenbelt, Maryland
●Wallops Flight Facility(WFF)	Supporting Organization	NASA Facility	Wallops Island, Virginia

Primary U.S. Work Locations
Maryland

Organizational Responsibility

Responsible Mission Directorate:

Mission Support Directorate (MSD)

Lead Center / Facility:

Goddard Space Flight Center (GSFC)

Responsible Program:

Center Independent Research & Development: GSFC IRAD

Project Management

Program Manager:

Peter M Hughes

Project Manager:

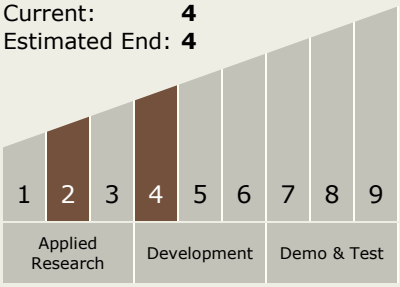
Stanley D Hunter

Principal Investigator:

Richard K Barry

Technology Maturity (TRL)

Start: **2**
Current: **4**
Estimated End: **4**



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Images

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science areas facilitated by PHAST

Science areas facilitated by this technology *(https://techport.nasa.gov/image/2700)*

Project Website:

http://aetd.gsfc.nasa.gov/

Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.1 Detectors and Focal Planes